

**THE ESTABLISHMENT OF SETBACK  
DISTANCE FOR MALODOUR MITIGATION  
FROM PALM OIL MILL**

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**THE ESTABLISHMENT OF SETBACK DISTANCE FOR MALODOUR  
MITIGATION FROM PALM OIL MILL**

**by**

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## **TABLE OF CONTENTS**

	<b>Page</b>
<b>ACKNOWLEDGEMENT</b>	<b>ii</b>
<b>TABLE OF CONTENTS</b>	<b>iii</b>
<b>LIST OF TABLES</b>	<b>viii</b>
<b>LIST OF FIGURES</b>	<b>x</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xiv</b>
<b>LIST OF SYMBOLS</b>	<b>xv</b>
<b>ABSTRAK</b>	<b>xvi</b>
<b>ABSTRACT</b>	<b>xviii</b>
<b>CHAPTER ONE: INTRODUCTION</b>	
1.1 Odour Nuisance from Palm Oil Mill	1
1.2 Introduction to Odour Generation and its Dispersion Mechanism	4
1.3 Setback Distance as Odour Control Technique	5
1.4 Problem Statement	6
1.5 Research Objectives	7
1.6 Scope of Study	8
1.7 Organization of the Thesis	9
<b>CHAPTER TWO: LITERATURE REVIEW</b>	
2.1 Introduction	11
2.2 Palm Oil Industries in Malaysia	11
2.2.1 Palm Oil Production Process	12
2.2.2 Palm Oil Mill Effluent Characteristic	14
2.2.3 Palm Oil Mill Treatment Ponds	17
2.3 Introduction to Odour	18
2.3.1 Characterization of Odour	19

2.3.2	Effects of Odour to the Environment and Public Health	23
2.4	Odour Formation and Volatilization	24
2.4.1	Odour Emission from Palm Oil Mill Effluent Treatment	25
2.4.2	Hydrogen Sulphide Formation in the Treatment Pond	27
2.4.3	Ammonia Formation in the Treatment Pond	29
2.4.4	Theory of Odour Evaporation and Odour Dispersion from Lagoon	31
2.5	Odour Regulations and Its Standards	32
2.5.1	Regulation Based on Odour Concentration Values	33
2.5.2	Regulations Based on Substances	36
2.5.3	Regulations Based on Distance	41
2.5.4	Regulations Based on Surveying Method	41
2.6	Odour Regulation by Setback Distance	43
2.6.1	Introduction to Setback Distance	44
2.6.2	Determination of Setback Distance by Using Dispersion Modelling	46
2.6.3	Determination of Setback Distance by Using In Field Assessment Method	47
2.6.4	Determination of Setback Distance by Using Simple Gaussian Plume Equation	47
2.7	Odour Sampling Techniques	49
2.7.1	Types of Odour Sources	51
2.7.2	Sampling Techniques at Point Source	51
2.7.3	Sampling Techniques at Area Source	51
2.8	Dispersion Modelling	52

2.8.1	Types of Dispersion Modelling	53
2.8.2	Overview of Dispersion Modelling	53
2.8.3	Introduction to CALPUFF	54
2.8.4	Data Needed in Running CALPUFF	56
2.9	Summary of Literature Reviews	57

### **CHAPTER THREE: METHODOLOGY**

3.1	Introduction	59
3.2	Survey on Odour Source Identification	62
3.2.1	Developing Questionnaire	63
3.2.2	Area Selection for Questionnaire Surveying	65
3.3	Site Selection of Palm Oil Mill	67
3.3.1	Description of Internal Monitoring Points	68
3.3.2	Description of External Monitoring Points	70
3.3.3	Description of Odour and Wastewater Sampling at Palm Oil Mill Treatment Ponds	72
3.4	Equipment Capabilities and Purpose	73
3.4.1	In-field Portable Olfactometer	73
3.4.2	Anemometer	74
3.4.3	Flux Hood	75
3.4.4	Vacuum Chamber	75
3.4.5	Gas Analyser	76
3.5	Odour Sampling Method and Analysis	77
3.5.1	On-site Odour Monitoring (Ambient Odour)	77
3.5.2	Odour Source Sampling (Area Source)	78
3.5.3	N-Butanol Test (Odour Assessor Test)	80

3.5.4	Olfactometer Test (SM100 Laboratory Mode)	81
3.5.5	Odour Emission Calculation	82
3.5.6	Odour Dispersion Modelling (CALPUFF)	83
3.5.7	Simple Gaussian Equation	86
3.6	Wastewater Quality Test	86
3.6.1	Wastewater Sampling	87
3.6.2	Palm Oil Mill Wastewater Analysis by Using Spectrophotometer	87
3.7	Statistical Analysis for Paired Sample t-test and Correlation	88

#### **CHAPTER FOUR: RESULTS AND DISCUSSION**

4.1	Introduction	89
4.2	Identification of the Odour Nuisance to the Community Close to the Palm Oil Mill	90
4.2.1	Perception of Odour Contribution	90
4.2.2	Level of Odour Annoyance Tolerance by Respondents	94
4.3	Characterization of Odour Emission from Palm Oil Mill	98
4.3.1	Identification of Odourous Area within the Palm Oil Mill	98
4.3.2	Odour Concentration of Acid, Anaerobic, Facultative and Aeration Ponds	101
4.3.3	The Relationship between Pond Odour Concentration and POME Physical Condition	105
4.3.4	The Relationship between Pond Odour Concentration and POME Biological Condition	110
4.4	Establishment of Suitable Setback Distance Values	119
4.4.1	Establishment of Setback Distance with In-field	120

Olfactometer and Odour Character	
4.4.2 Dispersion of Odour from Palm Oil Mill Effluent	132
4.4.3 Establishment of Setback Distance by Using Dispersion	134
Modelling CALPUFF	
4.4.4 Establishment of Setback Distance by Using Simple	142
Gaussian Plume Model Calculation	
4.4.5 Statistical Analysis and Comparison between Observation	147
and Prediction Odour Measurement Method	
4.4.6 CALPUFF Model Performance Analysis Using	157
Linear Regression	
4.4.7 Comparison of the Odour Setback Distance Values	158
 <b>CHAPTER FIVE: CONCLUSION</b>	
5.1 Research Conclusion	161
5.2 Recommendations	162
 <b>REFERENCES</b>	164
<b>APPENDICES</b>	
Appendix A: Dispersion Coefficient Graphs	
Appendix B: Questionnaire Surveying Form	
Appendix C: Wastewater DR2800 Methods	
Appendix D: Odour Concentration Data for Discrete Points (Receptors) by using	
CALPUF	
 <b>LIST OF PUBLICATIONS</b>	



## LIST OF TABLES

	<b>Page</b>
Table 2.1	List of palm oil mill around state in Malaysia 12
Table 2.2	Comparison of palm oil mill effluent (POME) characteristic by Chin et al. (2013) and Lam and Lee (2011) with wastewater discharge standard by Malaysia Department of the Environment (DOE) 16
Table 2.3	Percentage of waste from palm oil mill industry 26
Table 2.4	Odour standards for 22 specific odorous compounds in Japan before the regulation changed using odour index (The Offensive Odour Control Law in Japan) 37
Table 2.5	The advantages and disadvantage of using colorimetric tube either in-field or laboratory mode 39
Table 2.6	Details of the portable multi-gas detectors 40
Table 2.7	Comparison of wind tunnel and flux hood methods 52
Table 2.8	Dispersion modelling capabilities 54
Table 3.1	Seven odour intensity level start with level 0-not perceptible and end with level 6-extremely strong (Odour Methodology Guidelines, 2002) 63
Table 3.2	Odour annoyance level with lower level 0-definitely not annoying and highest level 8-extremely annoying (Good Practice Guide for Assessing and Managing Odour in New Zealand) 63
Table 3.3	List of questionnaire surveying area with distance (km) 67
Table 3.4	Details of the internal monitoring points in the mill 69
Table 3.5	Details of the external monitoring points (EXT1 – EXT18) with exact coordinate and distance from the odour source 71
Table 3.6	Details of the selected palm oil mill effluent treatment ponds 73
Table 3.7	Application information needed in CALPUFF for the UOP palm oil mill, Nibong Tebal 84
Table 3.8	Meteorological data details 85

Table 4.1	Odour concentration of ambient area at the palm oil mill with 2 OU is the minimum detection limit of the portable olfactometer. Morning sampling (a.m) is between 9 a.m. to 12 p.m. and evening sampling (p.m) is between 3 p.m. to 6 p.m.	99
Table 4.2	Descriptive analysis of four palm oil mill treatment ponds for odour concentration, temperature and pH	107
Table 4.3	Palm oil mill descriptive analysis of Sulphate, Sulphide, Ammoniacal nitrogen and Nitrate	111
Table 4.4	Descriptive analysis for H <sub>2</sub> S and NH <sub>3</sub> gases during 40 days sampling period	112
Table 4.5	Comparison of methods in finding the suitable setback distance for malodour from the palm oil mill	154

## LIST OF FIGURES

		<b>Page</b>
Figure 2.1	Palm oil mill process flow diagram start from fresh fruit bunch until the storage of palm oil (Harsono et al. 2014)	13
Figure 2.2	Process flow for palm oil mill effluent (POME) treatment pond	18
Figure 2.3	Graph of hydrogen sulphide dissociation that affected by changing of pH values (Stuetz and Frenchen 2001)	28
Figure 2.4	Hydrogen sulphide formation equation	28
Figure 2.5	Graph of ammonia dissociation that affected by changing of pH values (Sawyer and McCarty, 1978)	30
Figure 2.6	Major classical nitrogen removal routes in subsurface flow wetlands (Saeed and Sun 2012)	30
Figure 2.7	Example of a chromatogram for the mixture of odorous compounds by using GCMS method	38
Figure 2.8	The flow of two odour sampling methods. Static sampling method (a) with attachment of sampling container such as nalophan bag before being analysed and dynamic sampling method (b) without the sampling container and directly obtain odour concentration values (Vincenzo et al., 2013)	49
Figure 3.1	Research flow chart	60
Figure 3.2	Questionnaire location points around 4 km radius from odour source with 1 km distance for each radius	66
Figure 3.3	Location of study area, the palm oil mill as the odour source at Nibong Tebal that located in the South of Seberang Perai, Penang	68
Figure 3.4	Location of odour internal monitoring points that located in the mill with points internal 1 (INT1) until internal 12 (INT12)	69
Figure 3.5	External points (EXT1 – EXT18) map layout around 5 km radius from the odour source. Each radius represent 1 km	70
Figure 3.6	Layout of palm oil mill effluent ponds for odour and wastewater sampling. The sampling ponds were labelled as	72

	P1 (acid pond), P2 (anaerobic), P3 (facultative) and P4 (aeration)	
Figure 3.7	Portable olfactometer, SM100, in-field assessment procedure	78
Figure 3.8	Odour sampling method at area source by using flux hood	79
Figure 3.9	Odour test by using olfactometer in laboratory	82
Figure 3.10	CALMET domain image	85
Figure 4.1	The percentage of odour source according to 55 respondents	91
Figure 4.2	Location of the “no odour” area, area 7, area 8 and area 9 with minimum 2.5 km from the odour source (palm oil mill). Each circle represents 1 km radius	92
Figure 4.3	Percentage of the respondent perception towards the possible odour source (landfill, industries, sewage, poultry, others) by distance from nine surveying area	93
Figure 4.4	Percentage of the odour annoyance level by distance 1 km to 4 km from the odour source with level 1 as lower annoyance until level 8 as highest annoyance	95
Figure 4.5	Percentage of the odour intensity level by distance 1 km to 4 km from the odour source with level 1 as lower intensity until level 6 as highest intensity	96
Figure 4.6	Odour concentration data at the POME treatment ponds (P1: acid pond, P2: anaerobic pond, P3: facultative pond and P4: aeration pond) during five phases (one week averaging data each phase) of sampling	102
Figure 4.7	The box plot trend of the odour concentration at each treatment pond with palm oil mill effluent ponds (x-axis) and odour concentration, OU (y-axis)	104
Figure 4.8	Correlation between odour concentration and H <sub>2</sub> S	116
Figure 4.9	Correlation between odour concentration and NH <sub>3</sub>	127
Figure 4.10	Odour concentration (OU/m <sup>3</sup> ) of 18 external receptor locations (labelled as EXT1 to EXT18) observed in the morning, evening and night time for day 1. 1 <sup>st</sup> box (upper): morning, 2 <sup>nd</sup> box (middle): evening, 3 <sup>rd</sup> box (lower): night. White box represent “background odour or other odour” and black box represent “odour from the palm oil mill	122

Figure 4.11	Odour concentration (OU/m <sup>3</sup> ) of 18 external receptor locations (labelled as EXT1 to EXT18) observed in the morning, evening and night time for day 2. 1 <sup>st</sup> box (upper): morning, 2 <sup>nd</sup> box (middle): evening, 3 <sup>rd</sup> box (lower): night. White box represent “background odour or other odour” and black box represent “odour from the palm oil mill	123
Figure 4.12	Odour concentration (OU/m <sup>3</sup> ) of 18 external receptor locations (labelled as EXT1 to EXT18) observed in the morning, evening and night time for day 3. 1 <sup>st</sup> box (upper): morning, 2 <sup>nd</sup> box (middle): evening, 3 <sup>rd</sup> box (lower): night. White box represent “background odour or other odour” and black box represent “odour from the palm oil mill	124
Figure 4.13	Overall percentage (%) of odour character at the receptors	126
Figure 4.14	Odour frequencies from the POME at the 18 possible receptors around the mill	126
Figure 4.15	Wind rose at the palm oil mill during day 1 to day 3 with a) morning and b) evening monitoring time	130
Figure 4.16	CALMET terrain heights (m) with study area inside the red box. Most of terrain around the study area is between 100 m to 200 m	132
Figure 4.17	CALMET land use configuration with study area inside the red box. Most of land use around the study area is agriculture	133
Figure 4.18	Day 1 odour dispersion around 10 a.m (morning) by using CALPUFF air dispersion model. Study area is in the red box.	135
Figure 4.19	Day 1 odour dispersion around 4 p.m (evening) by using CALPUFF air dispersion model. Study area is in the red box.	135
Figure 4.20	Day 1 odour dispersion around 2 a.m (night) by using CALPUFF air dispersion model. Study area is in the red box.	136
Figure 4.21	Day 3 odour dispersion around 10 a.m (morning) by using CALPUFF air dispersion model. Study area is in the red box.	136
Figure 4.22	Day 3 odour dispersion around 4 p.m (evening) by using CALPUFF air dispersion model. Study area is in the red box.	137

Figure 4.23	Day 3 odour dispersion around 2 a.m (night) by using CALPUFF air dispersion model. Study area is in the red box.	137
Figure 4.24	The highest peak of odour concentration contour on day one	140
Figure 4.25	The highest peak of odour concentration contour on day two	140
Figure 4.26	The highest peak of odour concentration contour on day three	141
Figure 4.27	Predicted ground level odour concentration (OU), from odour source until 5 km distance with class C dispersion coefficient and different values of odour emission (OU/s) a)6678 OU/s, b)9696 OU/s and c)10184 OU/s	144
Figure 4.28	Predicted ground level odour concentration (OU), from odour source until 5 km distance with class D dispersion coefficient and different values of odour emission (OU/s) a)6678 OU/s, b)9696 OU/s and c)10184 OU/s	145
Figure 4.29	The predicted and observed odour concentration values by time	149
Figure 4.30	Correlation between predicted and observed odour concentration values	150
Figure 4.31	Odour concentration data for infield monitoring (observed) and CALPUFF (predicted) for point 1 to 9	155
Figure 4.32	Odour concentration data for infield monitoring (observed) and CALPUFF (predicted) for point 10 to 18	153

## **LIST OF ABBREVIATIONS**

UOP	United Oil Palm
USM	Universiti Sains Malaysia
POME	Palm Oil Mill Effluent
FFB	Fresh Fruit Bunch
DOE	Department of Environmental
ODT	Odour Detection Threshold
FIDOL	Frequency, Intensity, Duration, Offensiveness, Location
TLV	Threshold Limit Value
SRB	Sulphate Reducing Bacteria
PPM	Particle Particulate Matter
LRT	Long Range Transport
CALPUFF	California Puff Model
EPA	Environmental Protection Agency
MM5	Mesoscale Model
INT	Internal
EXT	External
OU	Odour Unit

## LIST OF SYMBOLS

$Q$	Pollutant mass emission rate
$U$	Speed
$x,y,z$	Axis along wind, crosswind, vertical distance
$H_e$	Effective stack height
$\sigma_y$	Horizontal dispersion coefficient
$\sigma_z$	Vertical dispersion coefficient
$\Delta h$	Plume rise
$E$	Specific odour emission rate
$C$	Odour concentration
$f$	Volume of carrier gas per unit time
$A$	Cross sectional area of flux hood



# **PENENTUAN JARAK SELAMAT YANG BAGI MENGURANGKAN BAU BUSUK DARI KILANG KELAPA SAWIT**

## **ABSTRAK**

Malaysia merupakan antara pengeluar terbesar minyak kelapa sawit. Semasa proses pengeluaran minyak kelapa sawit dijalankan, ianya akan mengeluarkan banyak efluen kilang minyak sawit yang menyumbang kepada masalah bau. Terdapat pelbagai kaedah dalam menguruskan bau busuk antaranya ialah penapis bio tetapi, kos bagi kaedah ini adalah tinggi dan proses penyelenggaraan yang mahal. Oleh kerana itu, salah satu kaedah yang lebih jimat tetapi berkesan ialah menggunakan kaedah jarak selamat. Kajian ini dijalankan bagi menguji keberkesanan tiga kaedah dalam mewujudkan jarak selamat: 1) pemantauan kawasan lapangan dengan menggunakan Olfaktometer, 2) model CALPUFF dan 3) pengiraan model penyebaran Gaussian. Oleh kerana tiada perbandingan penyelidikan yang telah dibuat dalam menggunakan ketiga-tiga kaedah sekali gus, pada akhir kajian ini perbandingan di antara kaedah-kaedah ini dari segi kesesuaian di Malaysia dan juga keberkesanan kaedah tersebut akan dibandingkan. Keputusan menunjukkan bahawa jarak selamat yang sesuai adalah pada 1.3 km dengan menggunakan pemantauan dalam lapangan, 1.2 km dengan menggunakan CALPUFF dan 0.5 km dengan menggunakan pengiraan model penyebaran Gaussian. Daripada ketiga-tiga kaedah, kajian menunjukkan terdapat perbezaan yang besar pada nilai kepekatan bau di kawasan sekeliling dengan nilai tertinggi 385 OU m<sup>-3</sup> bagi kaedah pemantauan kawasan lapangan, 6.1 OU m<sup>-3</sup> bagi model penyebaran dan 81 OU m<sup>-3</sup> bagi pengiraan model penyebaran Gaussian. Perbezaan tersebut adalah disebabkan

kepelbagaian di dalam cara mengendalikan kaedah-kaedah tersebut dan maklumat yang digunakan. Kajian ini boleh membantu di dalam kawalan bau di sekitar kilang kelapa sawit dengan menggunakan kaedah yang paling sesuai dan jarak selamat yang sesuai.

# **THE ESTABLISHMENT OF SETBACK DISTANCE FOR MALODOUR MITIGATION FROM PALM OIL MILL**

## **ABSTRACT**

Malaysia is the largest producer and exporter of palm oil. During the palm oil mill process, it will release an enormous amount of palm oil mill effluent which becomes a major odour problem. There are varieties of methods in managing the malodour such as biofilter, but those methods are expensive and high-maintenance. As the alternative, the setback distance method can be used as this approach is low-cost and effective. This research was carried out to verify the performance of three different setback distance methods: 1) in-field monitoring using Olfactometer, 2) the CALPUFF model and 3) the Gaussian plume model calculation. Since no research has compared the three methods, this study examined the suitability to be used in Malaysia and the effectiveness of the methods. Results show that the proper setback distances were 1.3 km by using in-field monitoring, 1.2 km by using CALPUFF model and 0.5 by using the Gaussian plume model calculation. Research shows that there a huge different in odour concentration value at the surrounding area from those methods with for 385 OU m<sup>-3</sup> in-field monitoring, 6.1 OU m<sup>-3</sup> for dispersion model and 81 OU m<sup>-3</sup> for Gaussian plume model calculation. The differences was cause by the different process in running the method and also the needed data. This research can recommend a proper way to build a setback distance and setback distance value to reduce odour nuisance in the areas around palm oil mills.

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1 Odour Nuisance from Palm Oil Mill**

Palm oil tree has many uses such as its leaves can be used to make a basket or a roof for a house, but the purpose of palm oil tree is that its fruits can be extracted to produce oil. This palm oil can be used in many ways, for example as frying oil, margarine and cocoa butter. It can also be used to make soap and detergent. Besides Indonesia, Malaysia is one of the world's largest palm oil exporters, amounting to 39 % of world palm oil production and 44 % of world exports (MPOB, 2014). In a global market, palm oil has made an impressive growth over the past four decades (Abdullah and Sulaiman, 2013). Palm oil mills are the industry that has been specified to carry out the palm oil processing where the extracting work of the oil from the fruit bunch was done there.

Despite the positive effect, the palm oil mill industry has always been related to the environmental issues, for example the establishment of the mill is believed to lead to issues of loss of habitats, deforestation, land degradation and also environmental pollution, such as water and air due to the effluent and chemical reaction release from the process (Liew et al., 2015). For example, the mill needs large quantities of water and energy during the production process and released large quantities of the solid waste, wastewater and also air pollution during the manufacturing process (Abdullah and Sulaiman, 2013). Besides that, even the oil palm industry leads to pollution as results from maintaining the plantation by using large quantities of pesticides and herbicides. During oil extraction process, large

quantities of water are used and about 50 % of the water contributes to the palm oil mill effluent (POME) (Abdullah and Sulaiman, 2013). From this, it can be said that the palm oil industry contributes to the environmental degradation both in production and its effluent.

Sterilization and clarification are the two main processes in the palm oil mill. Sterilization is the process used to cook the palm fruit with steam by using sterilizer. The steam will penetrate to the points of attachment of the fruits which is still attached to bunch. While clarification process is the crude oil extracted from palm oil by pressing the palm fruit to remove water and impurities (Rupani and Singh, 2010). These processes generate large amount of steam and hot water which will lead to the polluting of wastewater and also create odour problem to the river pollution, residential area round it and to the passersby (Ehsan and Wahid, 2013). Before it leads to a serious matter, prevention needs to be taken due to these environmental problems that can be caused from the increasing of crude palm oil production.

Over the past 20 years, the techniques that is applied for the POME treatment is mostly biological treatment pond that consists of anaerobic, facultative and aeration pond systems. This type of treatment is usually being called as the pond system or as a stabilization pond. Each of the ponds has its own function and each mill has its own number of ponds according to the design of the mill which the requirement of the waste or wastewater that generate during the process needs to be met. However, since the processes rely solely on microorganisms to break down the pollutants, this biological treatment system needs proper maintenance and monitoring. This is because, the microorganisms need great care to ensure they can do the degradation work effectively, thus suitable environment needs to be conducted in maintaining the microorganism condition (Ahmed et al., 2015).

Besides pond system, Malaysia now has been introduced to the digestive tank system to treat highly concentrated POME wastewater. This system is an alternative as it has more advantages such as the minimal formation of sludge, can avoid the unpleasant odour and the methane gas can be collected and be used as the renewable energy source. But the cost of building and maintaining the tank is expensive, which make the pond system is preferable compared to the tank system. Although the POME is organic, but it is still difficult to decompose it in natural ways and most of it converts the waste into a valuable products such as organic fertilizer and also feed stock (Rupani and Singh, 2010).

Besides the oily characteristics that gave a lot of problems in maintaining POME treatment ponds, it is also common for bad odour problem with total amount of hydrogen sulphide which can have detrimental effects on the environment (Chin et al., 2013). The main sources of the odour mainly from the degradation of the wastes and some of it from the chemical reactions, which happen during the process operation. Odour gases are different in each industry and because of the various mixes of chemical, the smell of each odour is unique and sometimes the source of the offensive odour can be detected just by smelling and the odour is identified. The difficulty in maintaining the problem to ensure less complaint and smooth performance over huge areas has not exactly been figured out yet.

As shown by anaerobic digestion of landfill industries, odour is likely to be caused by anaerobic process (Romain et al., 2013) because the anaerobic process emits hydrogen sulphide ( $H_2S$ ) and ammonia ( $NH_3$ ) (Zhou et al., 2013), thus the anaerobic process for POME is likely generated from the anaerobic digestion process.

## **1.2 Introduction to Odour Generation and its Dispersion Mechanism**

Odour pollution is widely recognised as the offensive air pollution due to human activity usually in populated areas. Odours that result directly or indirectly from human activities and that cause an adverse effect are often classified as contaminants and are subject to regulation (Nicell, 2009). Even though odorous substances are not directly toxic or harmful to human health, and their concentration in the air is usually far below the threshold limit value (TLV) fixed by health authorities (Sironi et al., 2007), long term exposure to malodour will induce different effects on human beings. Some studies suggest that the exposure to odours may cause emotional stresses such as states of anxiety, unease, headache or depression with physical symptoms (Capelli et al., 2011).

There are a lot of factors that cause odour generation and its dispersion. Temperature is one of the factors that affecting the air dispersion and the air molecules density. Even a small change in temperature will make a huge different in the atmospheric condition (Lecoq et al., 2016). This is necessary in verify the affect of the temperature toward odour dispersion as the night and day time has a huge different in temperature condition. The odour emission distance will be different during day time and night time because of its different mixing condition with the air. The molecules in hot air will adsorbed the energy in the form of heat and it will move faster compare to the molecules in the cold air. The energy that adsorbed by the molecules will make its air density decrease and tend to be further apart. This will make it less in weight and easily rise up to the atmosphere compare to the cold air which is sinking. The air during night time generally calmer and the emission

molecules usually will disperse forward instead of rise up to the atmosphere and therefore create an emission zone greater than usually occur during the day time.

Different approaches can be used in order to evaluate odour impact whether directly from its source or tracing the source. There are on site measurement, dispersion modelling and survey methods to be chosen that can be run simultaneously or independently depending on the odour situation. Some practitioners believe that prediction tools such as dispersion modelling are less effective compared to real-time tools such as direct sensory assessment or retrospective techniques such as complaints (Bokowa, 2010).

### **1.3 Setback Distance as Odour Control Technique**

Odour regulation to mitigate the odour problem can be built in different ways, such as types of substance or pollutant, odour concentration values and also build safe or buffer distance between the source and the receptors (Bokowa, 2010). Setback distance is one of the easy methods to be applied and selection of a setback distance is important to reduce industrial impact towards community. Setback distance is a distance that separates the source of nuisance from the community around it, but this approach needs a good land planning (Nicolas et al., 2008). An appropriate distance need to be measured to avoid the complaints from the resident around the source if the setback distance is insufficient, but over measurement of the setback distance will restrict the development of the industries (Schauberger et al., 2012).

There are two ways of measuring a suitable setback distance, first is by using experience based which is field inspection and second by using dispersion based